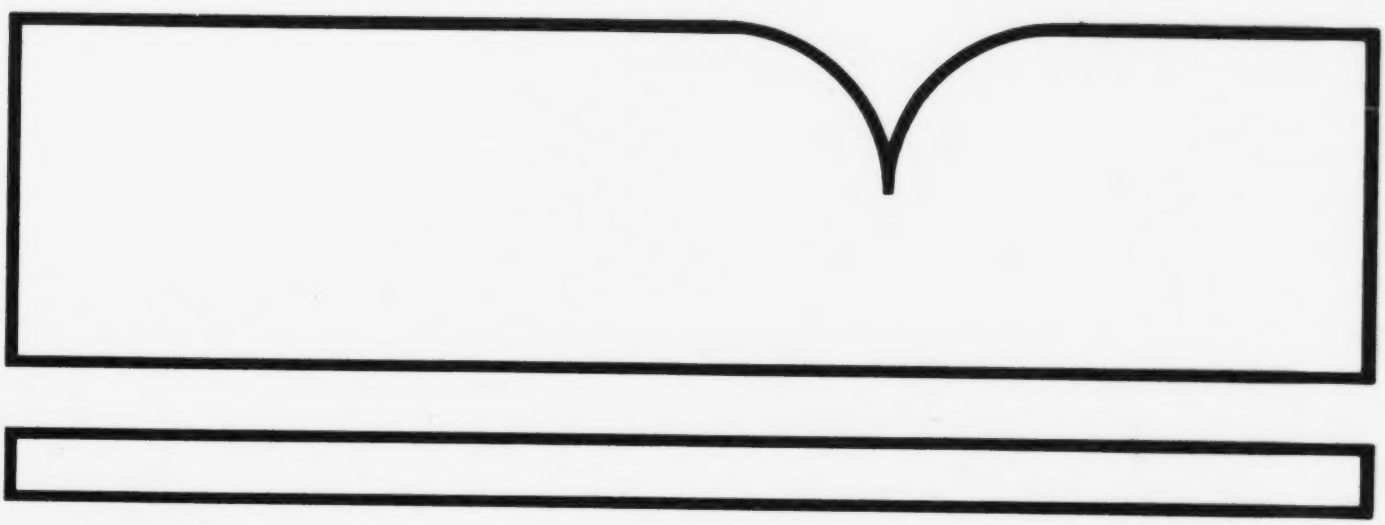
PB80-218050

Summary and Analysis of Comments Received in Response to Draft EPA Procedures for the Measurement of Tire Rolling Resistance and Subsequent Grading and Labeling of Tires

(U.S.) Environmental Protection Agency
Ann Arbor, MI

Jul 80



U.S. Department of Commerce
National Technical Information Service
NTIS

EPA-AA-SDSB-80-14

PB80-218050

Technical Report

Summary and Analysis of Comments Received in Response to Draft EPA Procedures for the Measurement of Tire Rolling Resistance and Subsequent Grading and Labeling of Tires

by

Glenn D. Thompson

July 1980

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Standards Development and Support Branch
Emission Control Technology Division
Office of Mobile Source Air Pollution Control
Office of Air, Noise and Radiation
U.S. Environmental Protection Agency

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NATIONAL TECHNICAL
INFORMATION SERVICE
U.S. DEPARTMENT OF COMMERCE
SPRINGFIELD, VA 22161

TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

1. REPORT NO. EPA-AA-SDSB-80-14	2.
3. RECIPIENT'S ACCESSION NO. PB80 218050	
4. TITLE AND SUBTITLE Summary and Analysis of Comments Received in Response to Draft EPA Procedures for the Measurement of Tire Rolling Resistance and Subsequent Grading and Labeling of Tires	5. REPORT DATE July 1980
	6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S) Glenn D. Thompson	8. PERFORMING ORGANIZATION REPORT NO.
9. PERFORMING ORGANIZATION NAME AND ADDRESS U.S. Environmental Protection Agency, Office of Mobile Source Air Pollution Control, Standards Development and Support Branch, Ann Arbor, Michigan 48105	10. PROGRAM ELEMENT NO.
	11. CONTRACT/GRANT NO.
12. SPONSORING AGENCY NAME AND ADDRESS	13. TYPE OF REPORT AND PERIOD COVERED technical
	14. SPONSORING AGENCY CODE
15. SUPPLEMENTARY NOTES	

16. ABSTRACT

As the initial step in developing a standardized acceptable test procedure for measuring tire rolling resistance EPA prepared a technical report, Determination of Tire Energy Dissipation-Analysis and Recommended Practices, in April 1978. This report and its draft recommended practice for determining tire energy dissipation ~~was~~ were circulated to the automotive and tire industries with a request for comments. The comments received were compiled and analyzed in a subsequent EPA technical report, Summary and Analysis of Comments Received in Response to the EPA Report, Determination of Tire Energy Dissipation, Analysis and Recommended Practices, which was released in January 1979.

As a result of this first analysis of comments the proposed recommended practice for determination of tire energy dissipation was substantially revised. This revised draft test procedure, together with a draft proposal for grading and labeling of tires for rolling resistance was again distributed with a request for comments to the automobile and tire industries in April 1980.

This report presents, summarizes and analyzes the comments received in response to the April 1980 destribution of the Draft EPA Recommended Practice for Determination of Tire Rolling Resistance Coefficients and the Draft EPA Recommended Practice for Grading and Labeling of Tires for Fuel Efficiency.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Tires Motor vehicles Automobiles Energy dissipation	Rolling resistance Grading Labeling	

18. DISTRIBUTION STATEMENT RELEASE UNLIMITED	19. SECURITY CLASS *(This Report)* UNCLASSIFIED	21. NO. OF PAGES
	20. SECURITY CLASS *(This page)* UNCLASSIFIED	22. PRICE

EPA Form 2220-1 (9-73)

INTRODUCTION

The area of tire rolling resistance, particularly as it affects the exhaust emissions and fuel economy of a vehicle, has been a concern to EPA for several years. For example, EPA Advisory Circular No. 55A, dated February 8, 1978 stated that:

> "Due to the potential for abuse of the option to alternatively determine the dynamometer power absorber setting and, in particular, the large effect of such potential abuse on the fuel economy test values, EPA is concerned that only validly determined and fully representative alternative dynamometer power absorber settings be used in certification and fuel economy testing. To this end, EPA has requested through this advisory circular data on the tires used on the coastdown vehicle, the tires used on all other vehicles which the original coastdown vehicle represents, and the tires which will be used in production."
>
> "EPA's request for data on production tires, which will be used to specify the tires to be installed on test vehicles, is intended as an interim measure to ensure tire representativeness."
>
> "At some later date, when a standardized, acceptable test procedure for measuring tire rolling resistance is available, this tire performance information will be requested rather than the categorical tire information requested through this advisory circular. Tire rolling resistance information will provide EPA with a better tool for specifying tires to ensure the representativeness of emissions and fuel economy data."

As the initial step in developing a standardized acceptable test procedure for measuring tire rolling resistance EPA prepared a technical report, Determination of Tire Energy Dissipation-Analysis and Recommended Practices, in April 1978. This report and its draft recommended practice for determining tire energy dissipation was circulated to the automotive and tire industries with a request for comments. The comments received were compiled and analyzed in a subsequent EPA technical report, Summary and Analysis of Comments Received in Response to the EPA Report, Determination of Tire Energy Dissipation, Analysis and Recommended Practices, which was released in January 1979.

As a result of this first analysis of comments the proposed recommended practice for determination of tire energy dissipation was substantially revised. This revised draft test procedure, together with a draft proposal for grading and labeling of tires for rolling resistance was again distributed with a request for comments to the automobile and tire industries in April 1980.

This report presents, summarizes and analyzes the comments received in response to the April 1980 distribution of the Draft

EPA Recommended Practice for Determination of Tire Rolling Resistance Coefficients and the Draft EPA Recommended Practice for Grading and Labeling of Tires for Fuel Efficiency.

SUMMARY AND ANALYSIS OF COMMENTS

Comments on the EPA Draft Recommended Practices were received from the following parties:

MTS Systems Corporation, Gerald R. Potts

SAE Rolling Resistance Subcommittee, Tom Baker, Chairman

Marion G. Pottinger and Nicholas M. Trivisonno

Rubber Manufacturers Association, Tom Cole

Motor Vehicle Manufacturers Association, Harry Weaver

ASTM Committee F-9 on Tires, W. Bergman

General Motors, T. Fisher

Ford Motor Co., Hellen Petrauskas

This section of the report presents and analyzes the significant technical aspects of the comments received from these respondents. The headings and subheading of the following sections of this report correspond to those of the original draft recommended practices. These recommended practices are provided as Attachments I and II of this report. The complete record of the comments which were received are also provided as Attachment III.

EPA Recommended Practice for Determination of Tire Rolling Resistance Coefficients

I. Introduction

Comments/Analysis

None.

II. Test Equipment

A. Tire Dynamometer

Comments

SAE, ASTM, RMA, MVMA, and Messers Pottinger and Trivisonno all commented that the requirement that the test machine determine tire energy dissipation by measurement of spindle reaction force was overly restrictive and that torque or energy methods should also be allowed. Messers Pottinger and Trivisonno specifically noted that

few machines in existence today were equipped to measure spindle force.

MTS commented that the recommended use of a 67.23 inch diameter tire test machine was unduly restrictive and suggested that the following statement be added to the EPA Recommended Practice.

> "The Development of Preferable Flat Surface Laboratory Apparatus is progressing a pace which may soon bring it into use. The recommended practice is written in such a way that it can be used without modification when such equipment becomes commonly available."

Analysis

There are several reasons why spindle force can be the preferred approach. The primary reason is that this approach has the minimum parasitic losses which are included, and must be corrected for, in the measured parameter. Spindle force measurements only include the spindle bearing losses in addition to the tire energy dissipation. The torque method also includes the test wheel bearing losses, and the energy method includes all of the parsitic losses of the system including the drive motor.

Spindle force also has the advantage that it may be easier to retrofit an existing machine for spindle force measurement than for torque measurement since the torque measurement modification requires instrumentation of the test wheel drive mechanism. Finally, it is possible to instrument multiple spindle force stations on a single test wheel and to thereby test multiple tires simultaneously.

The disadvantage of the spindle force method is that the load cell used to measure the force must be capable of accurately resolving the transverse tire dissipation forces in the presence of the large tire loading force normal to the test wheel. This resolution problem subsequently requires greater care in the test machine alignment and in the test machine operation than is required by the other methods.

There is no strong technical reason why other methods of measuring tire rolling resistance should not be allowed. Therefore, it is recommended that the EPA recommended practice be revised to state that measurements be made by spindle force transducers or by any other approach which yields equivalent results.

While measurement of tire rolling resistance on a 67" drum by instrumentation systems other than spindle force transucers are directly compatible with the current EPA Recommended Practice, the use of a flat surface machine is not. This incompatibility, occurs because the rolling resistance of the tire on a curved surface is higher than that on a flat surface. While several correction approaches have been proposed, no correction approach

was included in the EPA Recommended Practice because of the concern over the universal applicability of the available correction equations.

In the earlier version of the EPA Recommended Practice a flat surface test machine was proposed and virtually all commentors opposed this recommendation because of the limited availability of this type of test machine. Consequently at this time there does not appear to be any apparent alternative to recommending the 67" diameter test wheel. When flat surface machines are in greater service more data will be available to evaluate the accuracy of the curved-to-flat surface correction factors or to develop improved versions. At that time the EPA Recommended Practice can be revised to prefer the use of a flat surface machine with correction factors provided to allow continued use of a circular test surface.

1. Test Machine Alignment

Comments

The MTS corporation and Messers Pottinger and Trivisonno commented that the specified machine alignment tolerances were excessive for a spindle force machine. Messers Pottinger and Trivisonno recommended that the alignment accuracy should be $\pm 0.01°$ while Mr. Potts of MTS recommended alignment accuracy of $\pm 0.03°$ and that efforts be made to measure or eliminate the remaining cross coupling error.

In addition to the longitudinal alignment accuracy requirements Messers Pottinger and Trivisonno suggested that the slip angle tolerance be 0.01° and that:

> "For consistency we would make the wheel plane to test surface angle, 90° to within 0.01°."

Analysis

The analysis of the alignment problem presented by MTS was particularly convincing, consequently the allowable alignment tolerances should be reduced, particularly for longitudinal alignment. The comments on slip angle tolerance indicates that this parameter is not as critical as the longitudinal alignment. Consequently, based on the comments it is concluded that an alignment accuracy of 0.03° is sufficient for both longitudinal alignment and slip angle if care is taken to measure or eliminate any remaining cross coupling errors. The alignment accuracy is recommended. The more stringent alignment of 0.01° can, of course, be adopted by any test laboratory.

2. Test Machine Control Accuracy

Comments/Analysis

None.

3. Test Machine Instrumentation Accuracy

Comments

Messers Pottinger and Trivisonno commented:

"The spindle force accuracy of 0.1 lbf will require the use of very light-duty load cells preferably 100 lbs. or less. This requires very careful design and operating procedures to avoid incessant breakage."

Analysis

The precision of 0.1 lbf is considered quite desirable and is therefore specified in both the EPA and SAE recommended practices for measurement of tire rolling resistance. This comment therefore considered, primarily as a cautionary note, and is so appreciated.

B. Test Cell Requirements

1. Thermal Control

Comments

RMA and Messers Pottinger and Trivisonno commented that 100°F test cells are commonly availably for the DOT Federal Motor Vehicle Safety Standard 109 and that it would be perferable if such cells could be used for rolling resistance measurements. ASTM, however, commented that the allowable temperature range specified in the EPA recommended practice ±5°F could significantly affect the measured rolling resistance of tires.

Analysis

The average temperature environment of an in-use tire is closer to 75°F than it is to 100°F. Since the goal of the recommended practice is to promote fuel conservation through improved tires it is logical to choose a test cell temperature which approaches average in-use environment temperature, yet is easily attainable. The proposed test temperature, 75°F is such a compromise. The selection of such a common laboratory temperature should not impose a significant burden.

This is also the test cell temperature specified by the SAE Rolling Resistance Measurement Procedure for Passenger Car Tires - SAE J1269. It is therefore concluded that the nominal test cell temperature should remain at 75°F.

The ASTM comment that temperature significantly affects tire rolling resistance is in concurrence with EPA experience in testing light-duty vehicles. Furthermore, our experience indicates that it is difficult to accurately correct for temperature effects over

wide temperature ranges. Consequently we do not concur that the allowable test temperature range should be expanded to include 100°F.

The ASTM suggestion of adopting a temperature correction factor to adjust to a nominal 75°F within the current 70° to 80°F range is desirable. It is recommended that a temperature correction, of a form similar to that used in EPA Advisory Circular AC 55/C, be adopted. However, it is recommended that coefficient of the temperature correction not be specified at this time, but that data be requested from the commenters to provide a stronger data base for the determination of the value of this coefficient.

2. Temperature Measurement Precision

Comments/Analysis

None.

III. Test Procedure

A. Tire Mounting

1. Rims

Comments

The RMA commented:

"It is not certain what the effect of wide versus narrow rim width is on rolling resistance. Consequently, it is recommended that test rims be those specified by the Tire & Rim Association, Inc. as "design rim width," ±one-half inch. For tire sizes not standardized by the Tire & Rim Association, Inc., reference should be made to the standardizing organizations listed in Federal Motor Vehicle Safety Standard 109."

Analysis

The RMA comments appear reasonable and probably should be adopted.

2. Inflation Pressure

Comments

GM and the MVMA commented that all Alpha Numeric tires should be tested at the same inflation pressure rather than varying the inflation pressure with the tire load range. The same comment was made regarding "P" type tires.

On the subject of the recommended inflation pressures, ASTM, RMA, SAE and MVMA all recommended higher test inflation pressures,

generally 32 and 35 psi for Alpha Numeric and "P" type tires respectively.

The EPA recommended practice for measurement of tire rolling resistance included test inflation pressures for "T" type tires. RMA, Ford, MVMA and GM all commented that these tires are temporary usage tires and should be excluded from the rolling resistance measurement and grading procedures.

Analysis

From the standpoint of ranking tires it is unlikely that significant ranking changes would occur in the 6 or 8 psi range allowed for extra load tires. Therefore, in the interest of simplicity, a single inflation pressure is recommended.

The test inflation pressures prescribed in the draft recommended practice were intended to represent typical in-use inflation pressures. It is a major concern that the higher inflation pressures often recommended for current vehicles may not be maintained in actual consumer use. Still, there is a potential for fuel conservation by encouraging higher test inflation pressures. Consequently, it may be appropriate to use higher test inflation pressures and to stress in EPA information programs and in the labeling program that rolling resistance values were obtained at 32 or 35 psi, that these pressures are recommended and are safe for the tire operation. Such an approach would have little probability of misleading a consumer in tire selection and would provide some encouragement for increased inflation pressure. Consequently, adaption of these higher test pressures is recommended. The increase in the test inflation pressure will, of course, require a revision of the categories of the Recommended Practice for Tire Labeling and Grading.

To the extent that T type tires are only used as temporary "spares" it is reasonable to exclude them from the current procedure. Therefore, at the present time it is recommended that they be excluded. If such tires are used for common service or if such a tire designation is later used for common service tires then the determination of the energy dissipation of these tires should be considered.

B. Tire Break-In

Comments

The EPA recommended practice requires a one-hour tire break-in. SAE, RMA, MVMA, and GM all commented that break-in was not required for radial tires and, therefore break-in should only be required for non-radial tires. No specific data were provided by these respondents.

Analysis

The available data does indicate that tire break-in is more important for non-radial than for radial tires. However, such data are usually obtained under regulated pressure conditions rather than the capped method specified in the EPA Recommended Practice. Elimination of the break-in for radial tires tends to complicate the test procedure by introducing different test requirements for different tire types. It would probably also induce some increase in the variability of the results between the initial and subsequent tests of a tire. For these reasons it is recommended that tire break-in remain as part of the EPA Recommended Test Procedure for all tires. However, it should be noted that the recommendation which was made in the test equipment section, to allow alternate approaches which yield equivalent results, would also allow deletion of the tire break-in if break-in effects are negligible. Also, deletion of the break-in by a tire manufacturer could logically only result in a conservative rolling resistance grade for the tire. Therefore, there should be no objection if a tire manufacturer wishes to delete the break-in.

C. Thermal Conditioning

Comments/Analysis

None.

D. The Rolling Resistance Measurement

1. Installation on the Test Machine

Comments

This section of the EPA Recommended Practice states that the tire should be installed on the test machine, the normal load should be applied and then a final pressure check should be made. ASTM, RMA, MVMA, and SAE all commented that the order of the pressure check-machine installation sequence was not important, but that it was currently common practice to measure the inflation pressure of the tire prior to installation loading because this was more convenient for the test machine operator.

With respect to the final pressure inflation measurement, RMA, GM, and Messers Pottinger and Trivisonno all commented that the accuracy specified in the EPA Recommended Practice was excessively stringent. GM and Messers Pottinger and Trivisonno recommended a pressure gauge accuracy of 0.25 psi while RMA suggested 0.5 psi.

Analysis

The sequence specified in Draft EPA Recommended Practice is the typical sequence that would occur on an in-use vehicle. There is, however, little reason to believe that the order of the

sequence would have a measurable effect on the tire rolling resistance coefficient. Therefore, it is recommended that the sequence specified be revised to coincide with current common practice.

The GM comments estimated that the effect of an inflation error of 0.5 psi would be between 0.10 and 0.15 lbs. in tire rolling resistance. In general the Recommended Practice attempts to maintain an accuracy of 0.1 lb. whenever feasible. Consequently an inflation pressure accuracy of 0.25 psi would appear to be adequate while an inflation pressure accuracy of 0.50 psi is marginal. Consequently, it is recommended that the EPA Draft Recommended Practice be revised to specify an inflation pressure accuracy of 0.25 psi.

2. Tire Warm-Up

Comments/Analysis

None.

3. Rolling Resistance Measurements

Comments/Analysis

None.

4. Measurement of Parasitic Losses

Comments

A "skim" reading method in which the tire lightly contacts the test wheel was specified in the EPA Draft Recommended Practice as the method of determining the parasitic machine losses. Most commenters expressed reservations about this approach and expressed preference for a "machine" reading in which the tire is completely unloaded and only the residual machine signal is noted.

GM, however, expressed perference for an approach in which the rolling resistance of the tire is determined for a very light load and the rolling resistance coefficient then be determined by the measured change in the rolling resistance divided by the change in the load.

Analysis

The "machine" reading approach preferred by most commenters is the simplest approach. However, this approach does include the tire spindle bearing losses in the rolling resistance. To the extent that spindle bearing losses are different on different test machines this will result in some variability of the results between different test machines.

The approach recommended by GM has the advantage of removing the variations which might occur in spindle bearing losses. However, the GM approach does have the disadvantage of also subtracting the tire aerodynamic losses.

The ideal solution would be to remove the spindle bearing losses while retaining the tire aerodynamic losses. In this manner the measured tire rolling resistance would be closest to the load which a tire would impose on a vehicle on the road. However, the aerodynamic drag from the tire when on the test machine may be different from the drag when installed in a wheel well cavity. Consequently, it is concluded that it is more important to remove the variability induced by spindle bearing losses than it is to preserve the aerodynamic component of the tire losses. Therefore, it is recommended that the GM approach be adopted.

It should be noted that, use of a "machine reading" would result in a more conservative measurement of the tire rolling resistance and therefore, if adopted by a tire manufacturer this would not be objectionable as discussed in the previous section.

IV. Data Analysis

Comments

Minor editorial comments only.

Analysis

Corrections and revisions will be adopted as necessary.

EPA Recommended Practice for Grading and Labeling of Tires for Fuel Efficiency

I. Introduction

Comments

The introduction to this EPA Recommended Practice stated that tires had a significant effect on vehicle fuel consumption and that the measured rolling resistance coefficient of a tire was a good predictor of the fuel consumption effect of the tire. Several commenters, particularly Ford and ASTM questioned if measurement of the energy dissipation of a free rolling tire was adequate to predict in-use fuel efficiencies of tires.

In addition, these commenters expressed concern over the ability of consumers to conveniently utilize the tire grade information or to convert this information into predictions of the relative vehicle fuel consumption with different tire grades.

Analysis

The accuracy of the current proposed test procedure was also an original concern to EPA and was the reason that the EPA recommended practice of April 1978 included determination of tire energy dissipation over a transient cycle. Numerous comments and data submitted in response to this recommended practice indicated that the current simplified procedure is adequate to predict the fuel efficiency of tires. Data obtained by EPA also support this conclusion. Consequently, unless data supporting the need for more complex test procedures are developed, the current recommended practice is considered adequate.

With respect to the use of the tire grade information and the ability to convert this information into fuel efficiency, the use of letter grades was recommended specifically to simplify interpretation of the grading system. In addition, EPA will provide an information pamphlet to allow estimation of the relative effects on vehicle fuel efficiency of various tire grades.

II. Tire Grade Classification

Comments

ASTM and Ford both commented that the range of tire grades should be expanded. It was particularly noted that many current tires would fall in the highest rolling resistance categories and that perhaps additional higher rolling resistance categories should be provided.

Analysis

The proposed categories were selected to promote development

of improved low rolling resistance tires, and to provide a very simple system for ease of consumer use. Many current tires are included in the "D grade". However, it is expected that these tires will be improved as available technology permeates the tire manufacturing field. While it is certainly technically feasible to provide additional tire grade levels, the advantages of maintaining a simpler system appear greater than those of expanding the grading system to include tires which will tend to vanish from production.

III. Determination of the Grade of a Tire Design

Comments

Messers Pottinger and Trivisonno expressed concern that the proposed grading sytem could, in some instances, extenuate or mask true tire rolling resistance variations. Several examples were provided, which demonstrated the importance of small variations in measured rolling resistance when the results are near the boundaries of the categories. A numerical labeling system was proposed as an alternative approach.

In addition, GM proposed a tire grading system which would reduce or eliminate the tendency for smaller tires to qualify for higher rolling resistance grades than larger tires. The GM proposal essentially requires extrapolation of rolling resistance data versus test load for diverse size tires of a given design. The rolling resistance grade was then based on the intercept or zero load value of the extrapolated line.

Analysis

Whenever a category measurement or grading system is used there is always the possibility of some inequitable treatment near the category boundaries. However, a numerical labeling system would be inconsistent with the current DOT tire quality grading systems and would be more difficult for consumer use. In this instance the advantage of simplicity and consistancy provided by the category labeling sytem are judged to be greater than the disadvantages of such an approval.

There is merit in the concept of the GM proposal to attempt to make tire grades independent of tire size. Primarily, it is generally accepted that it is more difficult to manufacture low rolling resistance tires in small sizes. Consequently a given brand or design of tire might, under the current classification system, be a "grade B" tire in larger sizes yet only be a "grade C" tire in the smaller sizes. This would be a technically correct statement of the rolling resistance cofficient of the tire, but might cause some consumer confusion and diminish use of the system. Likewise this could prevent a general tire line from being advertized as "rolling resistance grade A tires" and therefore, reduce dissemination of the rolling resistance grade information in tire advertising.

There are, however distinct problems with the GM proposal. If the "adjustment factor" for tire size is determined and included in the EPA Recommended Practice then this single "fixed" value may not be appropriate for all tire technologies. If the adjustment factor is to be determined for each tire design, then the grade could become very dependent on the particular tires selected to determine this factor. In general, the logic of a floating adjustment factor is circuitous since the data obtained from the tests of diverse tires would be used to determine an adjustment factor based on the apriori decision that the tires tested were of equivalent design-technology, where as the purpose of the testing should be to determine or verify the rolling resistance technology of the tire.

It is recommended that a grading system which provides some adjustment for the tendency of smaller tires to have higher rolling resistance coefficients be developed. This system should be based on a predetermined or "fixed" adjustment factor. However, since GM was the only commenter suggesting such an approach, the proposed system should be distributed for comments before final adoption.

IV. Tire Labeling

Comments

GM commented that, "A simplified version (of the proposed label) such as 'fuel economy grade B' in dimensions consistent with the tire quality grading label should be adequate." Messers Pottinger and Trivisonno commented that point of sale information should be used rather than molded labeling.

Analysis

With respect to the location of the information it is considered essential that the information be available on the tire if the customer is to be assured that the rolling resistance information is applicable to the purchased tire. However, an adhesive label attached to the tire might be an acceptable initial alternative to sidewall molded information.

With respect to the size of the fuel efficiency label there are no technical reasons why the DOT quality grades and the fuel efficiency grades need be the same size. The fuel efficiency grade of tire should be of sufficient importance to warrent clear conspicuous labeling. It is questionable if the DOT quality grading labels, using letter 5/32 in. high can be considered clear and conspicuous.

In addition to the technical comments discussed in the previous sections general editorial comments were submitted. Corrections or modifications are recommended as necessary.

RECOMMENDATIONS

The issues which were raised in the comments received are

summarized in the following tables. These tables also summarize the recommended actions in response to these issues.

Table 1

Rolling Resistance Test Procedure

Issue	Recommended Resolution
Other measurement approaches, in addition to spindle force should be approved.	Provide allowance for the use of the measurement methods, particulary the torque approach.
Test machine alignment tolerances should be reduced, particularly for spindle force machines.	Adopt the proposed reduced alignment tolerance.
Resistance measurements in high temperature test cells (100°F) should be acceptable.	Reject the proposal.
Provide a temperature correction to correct rolling resistance measurements obtained in the range of 70° to 80°F to a nominal 75°F.	Adopt the proposal, however it is recommended that the correction coefficient which is developed be re-distributed for additional review and comments.
The proposed rim specifications should be more specific.	Adopt the proposed rim specifications.
All alpha numeric tires should all be tested at 32 psi independent of load range.	Adopt the proposal.
All "P" tires should be tested at 35 psi independent of the load range of the tire.	Adopt the proposal.
Delete temporary "T" type tires from the recommended practice.	Adopt the proposal.
Delete the break-in requirement for radial tires.	Include a statement that other procedures which yield equivalent results are acceptable. This will allow deletion of tire break-in of radial tires at a tire manufacturer's option if break-in does not significantly affect rolling resistance.
The sequence of loading tire followed by checking that inflation pressure should be changed to check pressure then load tire.	Adopt the proposal.

Table 1 (cont'd)

Rolling Resistance Test Procedure

Issue	Recommended Resolution
The accuracy of the tire inflation pressure gauge should be reduced to 0.25 psi.	Adopt proposal.
Change current "skim reading" approach for measurement of the machine parasitic losses to a "machine reading" or a modified "skim reading" approach.	Adopt the proposed modified "skim reading" method. A tire manufacturer could adopt the "machine reading" approach under the provision for "alternate methods which yield equivalent results."

Table 2

Grading and Labeling

Issue	Recommended Resolution
The rolling resistance of a free rolling tire may not be adequate to predict tire fuel efficiency.	No changes recommended. Sufficient EPA and general literature exist to demonstrate that the rolling resistance of a free rolling tire is a good predictor of the effect of the tire on vehicle fuel consumption.
The range of tire grades should be extended.	No change in the number of current categories, is recommended however, the resolution of the final issue somewhat reduces the need for expanded grades.
A continuous numerical grading system should be adopted instead of the proposed letter category system.	Reject the proposal to retain simplicity.
Rolling resistance grades should be dependent on tire load (size) in addition to rolling resistance coefficients so that there is not a tendency for small tires to have higher (inferior) grades.	Adoption of the proposal appears desirable, however since this proposal was only made by one commenter the proposed modficiation should be distributed for comments.

ATTACHMENT I

DRAFT

EPA Recommended Practice for Determination of Tire Rolling Resistance Coefficients

DRAFT

EPA Recommended Practice for Determination of Tire Rolling Resistance Coefficients

by

Glenn Thompson

March 1980

Standards Development and Support Branch
Emission Control Technology Division
Office of Mobile Source Air Pollution Control
Office of Air, Noise and Radiation
U.S. Environmental Protection Agency

I. Introduction

This test procedure determines the tire rolling resistance coefficient for a free rolling tire at a steady speed. This procedure conforms to the SAE Recommended Practice, Rolling Resistance Measurement Procedure for Passenger Car Tires - SAE J1269, generally adopting the recommended conditions of J1269 as the required standard conditions. The SAE Recommended Practice J1269 and the accompanying SAE information report J1270 may be consulted for additional information.

II. Test Equipment

The test equipment required is a tire dynamometer which measures the tire spindle reaction force as the tire is driven by a large cylindrical test wheel.

A. Tire Dynamometer

The test dynamometer shall be a cylindrical surface machine of 67.23 in (1.7076m) diameter. The test machine shall be capable of supplying a force on the tire perpendicular to the test surface, and shall be able to measure the reaction forces acting on the tire. During this process the machine must be capable of driving the test surface at constant speed. The width of the test surface must exceed the width of all test tires, and the test surface shall be coated with a medium coarseness abrasive (80 grit). As an example, medium grit 3M Safety-Walk represents a satisfactory surface.*

1. Test Machine Alignment

The direction of application of the tire load must be normal to the test surface within 0.3 deg (5.2 mrad). The wheel plane of the tire must be normal to the test surface within 0.3 deg (5.2 mrad) and parallel to the direction of motion of the test surface within 0.1 deg (1.7 mrad).

2. Test Machine Control Accuracy

Exclusive of perturbations induced by the tire and rim non-uniformities, the test equipment must control the test variables within the following limits:

---

* The manufacturer of this product is identified to clarify the example and does not imply endorsement of the product.

	U.S. Customary Units	SI Units
Tire Load	5 lbf	22 N
Surface Speed	1 mph	1 km/h

3. Test Machine Instrumentation Accuracy

The instrumentation used for readout and recording of test data must be accurate within the following tolerances:

	U.S. Customary Units	SI Units
Tire Load	2 lbf	8 N
Surface Speed	0.5 mph	0.8 km/h
Spindle Force	0.1 lbf	0.4 N
Loaded Radius	0.1 in	0.002 m

B. The Test Cell Requirements

The primary requirement for the test cell is that the ambient temperature be well controlled. In addition, the support services of compressed air should be available for tire inflation as should the necessary gauges to measure tire inflation.

1. Thermal Control

The ambient temperature in the vicinity of the test tire shall be 75 $\pm$ 5 °F (23.9 $\pm$ 2.7 °C).

2. Temperature Measurement Precision

The instrumentation used to measure the ambient temperature must be accurate to within 1 °F (0.5 °C).

III. Test Procedure

The test procedure consists of the following steps: tire mounting; tire break-in; equilibration of the tire to the test ambient temperature; adjustment of the cold inflation pressure; tire warm-up and then measurement of the tire rolling resistance.

A. Tire Mounting

1. Rims

The tire shall be mounted on test rims which have an approved contour and width as specified by the Tire & Rim Associations, Inc., for the size tire being tested. These rims shall have a maximum radial runout of 0.035 in (0.88 mm) and a maximum lateral runout of 0.045 in (1.14 mm).

2. Inflation Pressure

The inflation pressure of the tires after mounting shall be the inflation pressure specified for design purposes by the Tire & Rim Association, Inc. There pressure are specified in the following table for passenger car tires:

Alpha Numeric Size Tires	
Load Range B Tires	24 psi (165 kPa)
Load Range C Tires	28 psi (193 kPa)
Load Range D Tires	32 psi (221 kPa)
"P" Type Tires	
Standard Load Tires	26.1 psi (180 kPa)
Extra Load Tires	31.9 psi (220 kPa)
"T" Type Tires	
	60 psi (41,4 kPa)

The tire inflation pressure after mounting shall be correct to within 1 psi (6,8 kPa). The gauges used to measure this tire inflation pressures shall be accurate to within 0.5 psi (3.4 kPa).

B. Tire Break-in

Tires may undergo significant permanent growth upon first operation and therefore require an initial break-in and cooling period prior to the start of the test. A break-in run consisting of installing the tire on the tire test machine and operating the system under the test conditions for a period of 1 hour is required.

C. Thermal Conditioning

After initial break-in the tire shall be placed in the thermal environment of the test conditions for a minimum period of 3 hours before the test. During this period the tire inflation pressure should be checked and adjusted if necessary, to the design cold inflation pressure of the tire.

D. The Rolling Resistance Measurement

The test consists of loading the tire, a final pressure check; the tire warm-up, during which the tire temperature and inflation are allowed to increase as they should in typical service; followed by the rolling resistance measurement.

1. Installation on the Test Machine

The tire shall be installed on the test machine if not presently installed, and the load on the tire perpendicular to the test surface shall be adjusted to 80 percent of the design load of

the tire. At this time, the inflation pressure of the tire shall be checked and adjusted if necessary. The inflation pressure immediately prior to the test shall be correct to within 0.1 psi (0.68 kPa). The gauges used to determine this pressure shall be accurate to within 0.05 psi (0.34 kPa).

2. Tire Warm-up

The test tire shall be conditioned by operation at a speed of 50 mph for a minimum of 45 minutes.

3. Rolling Resistance Measurements

Following the tire warm-up and with the test dynamometer operating at 50 mph, the following parameters shall be recorded:

a. Tire spindle force
b. Normal load on the tire
c. Loaded radius of the tire
d. Angular velocity of the tire

4. Measurement of Parasitic Losses

As a final measurement, the parasitic machine losses shall be determined. The test machine speed shall be maintained at 50 mph while the load on the tire is reduced to the minimum value which will maintain the angular velocity of tire measured during the test. Under this condition the following parameters shall be determined:

a. Tire Spindle Force
b. Normal load on the tire

IV. Data Analysis

The data reduction consists of the correction for the machine parasitic loses, conversion to a tire energy dissipation force, and finally the computation of the tire rolling resistance coefficient.

A. Subtraction of Parasitic Losses

The spindle force measurement of the machine parasitics losses obtained in III. ~~E3~~ D4 shall be subtracted of the spindle forces measured during the test, III. ~~E2~~ D3. to obtain the net spindle reaction force.

B. Tire Energy Dissipation Force

The tire energy dissipation force shall be calculated from the net spindle reaction force by the following equation:

$$F_d = F_x (1 + r/R) \qquad (1)$$

Where: F_d = the tire energy dissipation force
F_x = the net tire spindle force lb (N)
r = the tire loaded radius, in (m)
R = The test surface radius, in (m)

C. Rolling Resistance Coefficient

The rolling resistance coefficient is calculated by dividing the energy dissipation force by the load force imposed on the tire:

$$C = F_d/F_z \tag{2}$$

Where:

C = Rolling resistance coefficient
F_z = Tire load, lb (N)

Equations 1 and 2 may be combined into the following single equation:

$$C = \frac{F_x(1 + r/R)}{F_z} \tag{3}$$

ATTACHMENT II

DRAFT

EPA Recommended Practice for Grading and Labeling of Tire for Fuel Efficiency

DRAFT

EPA Recommended Practice For Grading and Labeling of Tires For Fuel Efficiency

by

Glenn Thompson

March 1980

Standards Development and Support Branch
Emission Control Technology Division
Office of Mobile Source Air Pollution Control
Office of Air, Noise and Radiation
U.S. Environmental Protection Agency

I. Introduction

Tires have a significant effect on the fuel consumption of a vehicle.1/2/ This effect occurs because the energy dissipation in the tire affects the force required to propel the vehicle and hence the fuel consumed by the vehicle engine. Consequently the fuel efficiency of tires may be graded by their energy dissipation characteristics.

This document provides a grading classification system for tires, and provides the testing requirements necessary for a tire manufacturer to determine the grade of a tire design. Tires of a graded design may be labeled with their determined fuel economy grade. The final section of this document provides the criteria for the configuration of the label.

II. Tire Grade Classification

The grade of a specific tire is to be determined by the tire rolling resistance coefficient according to Table 1. The tire rolling resistance coefficients (RRC) are to be measured in accordance with the EPA Recommended Practice for Determination of Tire Rolling Resistance Coefficients.3/

III. Determination of the Grade of a Tire Design

A manufacturer may determine a grade for a tire design and use this grade for labeling all tires of this design.

In order to determine the grade of a tire design, a manufacturer shall randomly select and test sufficient tires from diverse production sites such that there is 90 percent statistical confidence that 90 percent of the tires produced will have rolling resistance coefficients less than the upper bound rolling resistance of that grade.4/

For example, if a manufacturer wishes to determine a RRC grade for his "Super Rounder" tires, 24 sample tires might randomly be selected from the 4 production lines manufacturing these tires. These 24 tires might than be tested by the EPA Recommended Practice obtaining the results of Table 2.

The requirement for labeling "Super Rounders" as a grade A tire is that the value computed from the sample data, such that there is 90 prcent confidence that 90 percent of the tires produced will have RRC below this value is less than 0.012.

NOTE: All references referred to in this paper are shown as _/.

Table 1

Tire Rolling Resistance Coefficient	Tire Fuel Efficiency Grade
RRC < 0.012	A
0.012 ≤ RRC < 0.014	B
0.014 ≤ RRC < 0.016	C
0.016 ≤ RRC	D

Table 2

Measured Tire Rolling Resistance Coefficients

Test Tire No.	Production Line A	B	C	D
1	.0123	.0113	.0134	.0115
2	.0126	.0101	.0121	.0111
3	.0125	.0104	.0119	.0113
4	.0110	.0132	.0115	.0119
5	.0127	.0101	.0133	.0115
6	.0126	.0115	.0104	.0134

Mean $\overline{RRC} = 0.01182$

Std. dev. $S = 0.00102$

That is:

$$Xu = \overline{RRC} + K \cdot S < 0.012 \qquad (1)$$

Where,

Xu = the upper bound such that there is a given confidence that a given percentage of the tires produced will have rolling resistance coefficients below this value.

$\overline{RRC}$ = the mean of the measured rolling resistance coefficients.

K = the "K factor" (given in Table 3).

S = the sample standard deviation.

In this example K for a sample size of 24 is given by Table 3 as 1.712. Therefore:

$$Xu = 0.01182 + 1.712\ (0.00102) \qquad (2)$$
$$= 0.0136$$

Since Xu > .0120, Super-Rounders cannot be labeled grade 'A'. But .0120 < Xu < .0140; thus, we are 90 percent sure that 90 percent of Super-Rounders have RRC < .0136 < .0140; consequently Super-Rounders can be labeled as grade 'B'.

IV. Tire Labeling

For any tire design meeting the criteria of section III, determination of the Grade of a tire Design, all tires of this design may be labeled with their Fuel Economy Grade.

The Fuel Economy GRADE label shall be permanently affixed to the tire (molded into or onto the tire would meet this condition) in a location which is conspicious where it is installed on a vehicle. The label may take either of the following forms, in which a Grade B tire is presented as an example.

"Fuel Economy GRADE B as Determined By EPA Procedures"

"EPA Fuel Economy GRADE B"

All letters shall be of "Futura Bold, Modified, Condensed or Gothic" type. The word "grade" and the letter designation of the grade shall be at least one-half inches (12mm) tall. The remaining words shall be in letters at least three-sixteenth inches (5mm) tall. Example labels are shown in Figures 1 and 2.

Table 3

Factors For One-Sided Tolerance Limits For Normal Distributions

Factors K such that there is 90 percent probability that at least 90 percent of the distribution will be less than $X + K \cdot S$ (or greater than $X - K \cdot S$), where X and S are estimates of the mean and the standard deviation computed from a sample size of n.

n	K
3	4.258
4	3.187
5	2.742
6	2.494
7	2.333
8	2.219
9	2.133
10	2.065
11	2.012
12	1.966
13	1.928
14	1.895
15	1.866
16	1.842
17	1.820
18	1.800
19	1.781
20	1.765
21	1.750
22	1.736
23	1.724
24	1.712
25	1.702
30	1.657
35	1.623
40	1.598
45	1.577
50	1.560

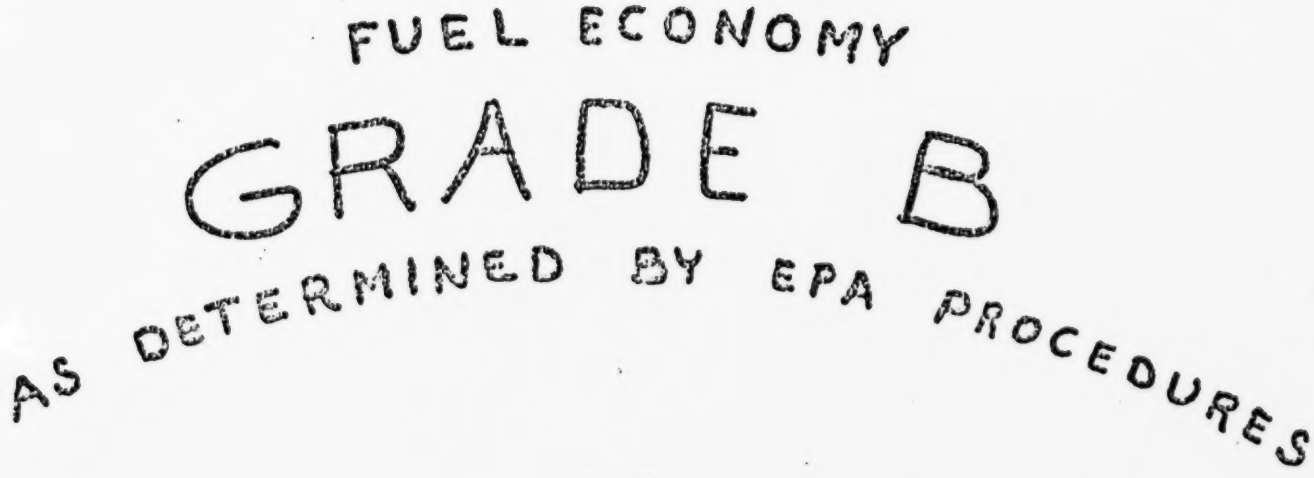

FIGURE 1

Reproduced from best available copy.

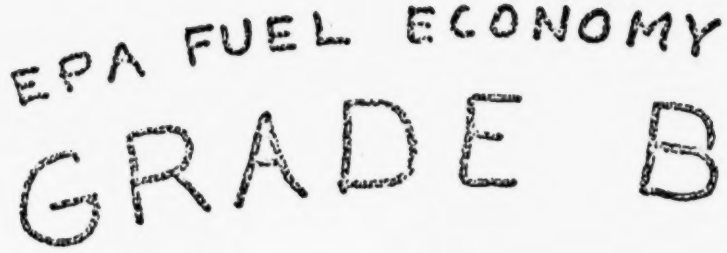

FIGURE 2

The labeling of tires is intended to allow manufacturers of truly fuel efficient tires to advertise this beneficial aspect of their tires. Advertising which uses the designated label without proper adherance to the test procedures, including procedural documentation, is prohibited. Evidence of such prohibited label use will be referred to the Federal Trade Commission (FTC) for their consideration for appropriate action.

References

1/ Klamp, W. K., "Power Consumption of Tires Related to How They Are Used," Procedings of the 1977 SAE-DOT Conference, Tire Rolling Losses and Fuel Economy - An R&D Planning Workshop.

2/ Yurko, J. "Tire Related Effects on Vehicle Fuel Economy," U.S. Environmental Protection Agency Technical Report SDSB.

3/ Thompson, G. "EPA Recommended Practice for Determination of Tire Rolling Resistance Coefficients," U.S. Environmental Protection Agency Technical Report (Draft March 1980).

4/ Experimental Statistics National Bureau of Standards: Handbook 91 U.S. Dept. of Commerce (1966).

ATTACHMENT III

DRAFT

Comments Received in Response to
the Draft EPA Recommended Practices

ATTACHMENT III

Comments Received in Response to
the Draft EPA Recommended Practices

MTS
MTS SYSTEMS CORPORATION
BOX 24012, MINNEAPOLIS, MINNESOTA 55424
TELEPHONE 612-944-4000 TELEX 29-0521 CABLE MTSSYSTEMS

15 April 1980

Mr. Charles L. Gray Jr.
Director
Emission Control Technolgy Division
United States Environmental Protection Agency
Ann Arobr, MI 48105

Subject: EPA Recommended Practice for Grading and Labeling of Tires for Fuel efficiency, EPA Recommended Practice for Determination of Tire Rolling Resistance Coefficient; March 1980

Dear Mr. Gray:

This is to communicate my thinking concerning the subject test and grade labeling procedures, as follows:

1. The machine alignment accuracy range specified in paragraph II.A1 of the proposed EPA Grade Labeling procedure will result in machine to machine differences at least 5 times larger than the EPA Proposed Tire Fuel Efficiency Grade ranges. More particularly, an F_x alignment error of F_x error = P sin ± 0.3
where P = tire load
will result in a rolling resistance coefficient error range of

$$\text{RRC}_{\text{error range}} = \frac{F_x \text{ error}}{P} = \sin(+0.3) - \sin(-0.3)$$

$$= 2 \sin 0.3$$

$$= 0.0105$$

In fact the entire range from A thru D of Table 1 of the Proposed Grading and Labeling Procedure is only 0.016 - 0.012 = 0.004. I suggest that one of the following four courses of action be pursued.

A) Specify machine alignment to $\pm 0.03^{\circ}$, producing a cross-coupling error range of 0.00105. This is still a sizeable error of 1 lb. per 1000 lbs. of F_z tire load.

B) Specify that test be run both clockwise and counter-clockwise and the results averaged to remove the cross-coupling bias error.

C) Measure and eliminate the cross-coupling error using suitable calibration procedures.

D) Test using sensing techniques that are insensitive to the load application alignment (e.g., roadwheel drive torque, carriage reaction measurement).

2. The specification of only a 67.23 inch diameter roadwheel machine unduly restricts the adoption of today's new generation of flat surface testing machines. An example of such a machine is shown on pages 4 and 5 of the enclosed product brochure, "MTS Tire and Wheel Testing Capabilities." There are currently six such machines on order, two of which have rolling resistance measurement capability with one of these to be shipped within the month. Previously experienced tire support bearing problems cited in EPA test reports have been solved on this machine and, although this system has not yet been widely distributed in the tire industry, it is now a practical reality.

   I suggest that the following SAE statement be added to paragraph II.2, "The Development of Preferable Flat Surface Laboratory Apparatus is progressing a pace which may soon bring it into common use. The recommended practice is written in such a way that it can be used without modification when such equipment becomes commonly available."

3. Paragraph III.A2 and III.D1 do not agree as to tire pressure accuracy specified.

4. Reference to paragraph III.E3 and III.E2 in paragraph IVA should read III.D3 and III.D2.

Thank you for the opportunity to respond to the subject procedures. If I may be of further service in clarifying these matters, please contact me at 612/944-5409.

Sincerely yours,

MTS SYSTEMS CORPORATION

Gerald R Potts

Gerald R. Potts
Manager
Tire/Wheel Test Systems

GRP/jmr

cc: Glenn Thompson - EPA

Encl: MTS Brochure 114.08-02
MTS Tire and Wheel Testing Capabilities

AIR SPACE

Society of Automotive Engineers, Inc.

Committee:
Rolling Resistance Sub-Committee

Reply To:
T. P. Baker, Chairman
SAE Rolling Resistance Sub-Committee
Uniroyal, Inc.
6600 E. Jefferson Ave.
Detroit, Michigan 48232

April 14, 1980

Mr. Charles L. Gray, Jr., Director
Emission Control Technology Division
United States Environmental Protection Agency
Ann Arbor, Michigan 48105

Dear Mr. Gray:

Thank you for your recent letter and the two attached Draft Recommended Practices for the Measurement and the Grading of tires for Rolling Resistance. I am very pleased to have this opportunity to respond on behalf of the SAE Tire Rolling Resistance Sub-Committee. My comments are as follows:

We are very pleased that the EPA has recognized the merits of our SAE Rolling Resistance Measurement Procedure for Passenger Car Tires - SAE J1269 by adopting many of its features as the framework for the EPA Draft Procedure. We believe that with present technology a steady state test of this nature is quite satisfactory for the purpose you intend. SAE J1269 has the added advantage that it is a familiar test and already widely accepted, as you mention in your letter.

With regard to in-use and test inflation pressures, I would like to point out to you that the pressures specified in J1269 were arrived at in anticipation of higher pressures being adopted generally throughout the automotive industry, and by the motoring public. Our intention was to draft a document which would be in tune with the 1980's, as opposed to one whose pressures would soon be obsolete. To the extent that the industry has been slower than we expected in making this change, our recommended pressures are ahead of their time.

Time has not stood still, however. Manufacturers are specifying higher pressures for some new vehicles and more will be added to the list in the 1981 model year. In addition, the public is receiving more and more messages extolling the virtues of maintaining higher inflation pressure for safety, fuel economy, and treadwear. Therefore, it is likely that T&RA design pressures are no better a reflection of in-use pressures than are the J1269 pressures at the present time; and in-use pressures may approach J1269 pressures as time goes on.

In view of the foregoing, I would encourage the EPA to publicly endorse higher inflation pressures and to help lead the way by adopting higher pressures in the Draft Recommended Practice. To do otherwise implies satisfaction with lower pressures, which I am sure you do not intend.

The EPA Draft Measurement Procedure is more restrictive than J1269 in several important features which we believe should be broadened to include current practices. One is the specification of the tire spindle reaction force measurement, which implies the exclusion of the torque method and the energy method. The torque and energy methods are in widespread use, and are demonstrably as reliable as the force method. Therefore, we can see no reason for their exclusion.

Another unnecessary restriction is the requirement of a break-in run for all tires, whether they need it or not. We suggest that only tires which undergo significant permanent growth need be broken in, and that the break-in be omitted where supporting evidence can be produced to justify the omission.

The EPA Draft Test Procedure calls for the measurement of parasitic losses by what we know as a "skim reading". Many laboratories have found that a "skim reading" is not as reproducible as a "machine reading" in which the tire is removed completely from the test surface. The difference, of course, is in the tire spindle bearing loss and the aerodynamic loss of the tire, as explained in SAE J1270, section 7.1. For the sake of more reliable end reproducible test data we recommend that the EPA Draft be modified to allow the use of a "machine reading" which is current practice in most rolling resistance test laboratories today.

Another point of difference, which may at first seem trivial, is that the EPA Draft calls for loading the tire prior to the cold inflation pressure check; whereas the SAE procedure is unclear as to the sequence of these events. In actual practice, most test laboratories make the pressure check prior to loading the tire. In some cases it makes little difference to the test operator which comes first; but in laboratories where the test is operated from a remote location, sometimes even from another room the requirement of loading first and then checking pressure imposes a penalty on test efficiency. We agree that the sequence should be specified, but we recommend that it be specified in the opposite order in order to bring it into line with current practice.

I have only one comment on the EPA Draft for Grading and Labeling. It concerns an apparent inconsistency between the definition of the grades as given in Table 1 and the procedure for establishing a grade as given in Section III, paragraph 2. Although the grades in Table 1 have upper and lower bounds, only the upper bound is used to establish a tire's grade. Furthermore, Grade D has no upper bound to compare the test results to. I think the intention of the Draft can be inferred by the reader, but it needs more work to make it unambiguous in this area.

Emission Control Technology Div.
U.S. Environmental Protection Agency
Ann Arbor, Mich.

I trust these comments will prove useful to you as you give further attention to this subject.

Sincerely,

T. P. Baker

T. P. Baker, Chairman
SAE Rolling Resistance Sub-Committee

cc: Mr. R. T. Northrup - SAE

1465 N. Hametown Road
Akron, Ohio 44313
April 17, 1980

Mr. Charles L. Gray, Jr., Director
Emission Control Technology Division
United States Environmental Protection Agency
Ann Arbor, Michigan 48105

Dear Mr. Gray:

We received a copy of your letter and Glenn Thompson's drafts from Gerald R. Potts of MTS through ASTM. With the exception of one procedural comment all other comments will be technical. The exception is that: either desired deadlines should be extended or a more prompt means of communication should be established as many of us never see the Federal Register.

Our technical comments will refer to Glenn Thompson's draft, "EPA Recommended Practice for Grading and Labeling of Tires for Fuel Efficiency," March, 1980.

Page 1a, III. Determination of the Grade of a Tire Design

We basically agree with the statistical idea of deciding the grade for a tire design, but do see significant problems: the scheme of tire grading, the method of sampling, certain statistical points, and labeling difficulties.

The scheme of tire grading into four distinct categories does not reward those who improve their product within a grade, it unduly punishes those who are only slightly worse, and it could lead to endless haggling and law suits. We would like to amplify these points by bending Glenn Thompson's example.

Let us suppose that company "A" makes "super rounders" and company "B" makes "maxi-tractions." Suppose now for simplicity that "super rounders" and "maxi-tractions" have precisely identical standard deviations, $S = 0.00102$, but different means. Also assume that we are using the proposed grades in Table I with the necessary misprint correction that for grade D, $0.016 \leq RRC$.

Suppose that for "super rounders," $\overline{RRC} = 0.01030$, then their $X_u = 0.01205$ (grade B) and that for "maxi-tractions," $\overline{RRC} = 0.01215$, then their $X_u = 0.01390$ (grade B). Is the difference significant? Yes. Is Company "A" rewarded competitively for a better job? No. The customer is misinformed.

Suppose now that for "super rounders," $\overline{RRC} = 0.0102$, then their $X_u = 0.01195$ (grade A) and that for "Maxi-tractions," $\overline{RRC} = 0.0103$, then their $X_u = 0.01205$ (grade B). Is the difference significant? No. Isn't company "B" at an exaggerated competitive disadvantage with respect to company "A"? Yes. The customer is misinformed.

For the preceding two cases the use of actual numerical grades similar in form to the EPA estimated fuel economy for automobiles would serve to better inform the customer and to foster competition. To best use numerical grades point of sale information like the estimated fuel economy brochure should be used instead of molded-on grade labeling. We believe this would be advisable for other reasons and will return to this subject a bit later.

Suppose that company "A" tests its sample of "super rounders" and gets $\overline{RRC} = 0.0102$, then their $X_u = 0.01195$ (grade A) and that later EPA tests a sample and gets $\overline{RRC} = 0.0103$, then their $X_u = 0.01205$ (grade B). Are the answers significantly different? No. Will an insuing fight over this help anyone? No. Therefore, we should seek a way to prevent this type of thing from occurring. Again numerical grades might help by not creating sharp arbitrary distinctions which blow insignificant differences up to monumental, time wasting, arguments. Also, it really won't help customers if companies must be hyper-conservative in self defense. NHTSA has already been concerned with how grades are set for UTQG wear ratings. They are looking at self defense in the face of uncertainty.

Of course, the validity of the whole procedure depends on adopting a standardized sampling method for use by both industry and the EPA.

Practical considerations and past experience indicate that the same tire design made in different plants is going to vary in rolling resistance, depending on where it is made. Larger size tires usually have somewaht lower rolling resistance coefficients (RRC) than smaller sizes, everything else being equal and since all sizes are not in production at once, tire age must be considered. Therefore, the 90% confidence level value will depend on how the sample is taken. Ideally, all plants and all sizes should be weighted to reflect the contribution of each plant and each size to the total population of that given tire design. But this would be a very unwieldy, perhaps impossible, situation. A simple, reasonable cost, sampling technique is, thus, an absolute prerequisite to implementation.

Page 4a, IV. "Tire Labeling"

We have just suggested that point of sale information be used not molded on labeling. If, however, molded on labeling does indeed occur, it would be very desirable if the various agencies would get together and look at what already exists. Standardization would be very nice, and if we keep going willy nilly, the companies will run out of space on the sidewall.

Page 1b, II. "Test Equipment"

It would be well to recognize other types of test equipment as well as the spindle force type in the standard. There are not many spindle force machines now in existence. Spindle force machines are physically fragile in routine use as will be pointed out below. SAE J1269 NOV79 recognizes other methods.

Page 1b, IIA1. "Test Machine Alignment"

For a spindle force machine we do not believe that the stated tolerances which are from SAE J1269 are adequate. A load alignment error of 0.3° which is allowed in the proposal will produce an interaction of 5.74 lbs/1000 lb load. This is quite high, about 1/2 of the actual data amplitude. Interactions should be limited to a much lower order, about 0.2 lb per 1000 lb, and still accounted for. We would, therefore, recommend the load be normal to the surface within 0.01°. It is worth noting that the preceding comments illustrate that the spindle force machine is very sensitive to small misalignments.

The procedure specifies that slip angle, wheel plane alignment parallelness to the test surface direction of motion, must be less than 0.1°. A 0.1° slip angle could cause a drag error of 0.21b, which is greater than the specified accuracy. Furthermore, tires are usually a little assymetrical with respect to slip angle, so a slip angle to the right could have a different effect than a slip angle to the left. Usually the minimum value of drag occurs at some small value of slip angle in a given direction. We would suggest that slip angle be within 0.01°.

For consistency we would make the wheel plane to test surface angle, 90° to within 0.01°.

Page 2b, IIA3. "Test Machine Instrument Accuracy"

The spindle force accuracy of 0.1 lbf will require the use of very light duty load cells preferably 100 lbs or less. This requires very careful design and operating procedures to avoid incessant breakage. This is a cautionary note based on our own experience with very light duty load cells in tire force measuring heads.

Page 2b, IIB1. "Thermal Control"

Not many machines are now in air conditioned environments. Time for putting the machines in such environments must be allowed or else it might be better to use a 100°F environment as used for endurance testing. This environment is already widely available.

Page 4b, IIID1. "Installation on the Test Machine"

The pressure gauge which meets SAE J1269 doesn't really exist. There is a definite precision problem even for electronic gauges in measuring to ±0.05 PSI while covering a range up to over 60 PSI. We are also concerned that measuring the pressure will produce changes in excess of the intended inflation precision for the test, 0.1 PSI. This is an area that needs careful attention so that a realistic standard can be drawn. In our own work, we try for an inflation accurate to within 0.25 PSI which is one part in one hundred for the lowest test pressure we use.

Page 4b, IIID4. "Measurement of Parisitic Losses"

The tire angular velocity depends on load. It will go down as load decreases. Thus, an unchanged angular velocity cannot be called out in the

process of attempting to measure windage or bearing losses. It would be better to call out a measure of angular velocity variation or to use a completely unloaded condition as the tare condition.

Page 4b, IVA. "Subtraction of Parasitic Losses"

E3 should be D4 and E2 should be D3.

The comments in this letter are our own and should not be construed as a statement of position by our employer, The BFGoodrich Company.

Sincerely,

Marion G. Pottinger

Nicholas M. Trivisonno

MGP/NMT/cs
2Z

RMA

RUBBER MANUFACTURERS ASSOCIATION

1901 PENNSYLVANIA AVE., N. W. • WASHINGTON, D. C. 20006 • (202) 785-2602

May 23, 1980

Mr. Charles Gray, Director
Emission Control Technology Division
Environmental Protection Agency
2565 Plymouth Road
Ann Arbor, Michigan 48105

SUBJECT: 1) EPA Draft Recommended Practice for Determining Tire Rolling Resistance Coefficients

2) EPA Draft Recommended Practice for Grading and Labeling of Tires for Fuel Efficiency

Dear Mr. Gray:

On March 24, 1980 we received your undated letter which contained copies of the two subject documents. We are pleased to note that the draft test procedure is similar to SAE J1269 Recommended Practice, Rolling Resistance Measurement Procedure for Passenger Car Tires. However, since the SAE J1269 does not include procedures for truck tires, we have restricted our comments to include passenger car tire rolling resistance considerations only.

There are some technical reservations we have concerning the EPA draft grading system which we have not addressed here, since we believe that we should first try to resolve the technical details of the test procedure. Once these have been settled, your proposed grading system can then be adequately evaluated for technical comment.

Specific comments concerning the EPA draft test procedure follows:

II. The EPA Draft measurement procedure is more restrictive than SAE J1269 and should be broadened to include current practices. The specification of the tire spindle reaction force measurement implies the exclusion of the torque method and the energy method. The torque and energy methods are in widespread use, and are demonstrably as reliable as the force method. Therefore, the EPA specification should be revised to include as alternatives both the torque and energy methods.

SAE Paper 780636 ("Interlaboratory Tests for Tire Rolling Resistance" by D.J. Schuring and S.K. Clark) discusses machine to machine variability. Absent a calibration method, grade ranges would have to take into account anticipated machine to machine variability.

II.B.1. Federal Motor Vehicle Safety Standard 109 requires that the air surrounding the test area be 100 ± 5°F. Since it would be practical and necessary in some cases to conduct rolling resistance tests at the same location as the FMVSS 109 tests, II.B.1. should be revised to permit other room testing conditions, provided a suitable conversion is used to compensate for the different conditions as permitted by paragraph 4.6.1 of SAE J1269.

Conversion from english to metric units should be made in accordance with recognized practice. It appears that the implied temperature measurement precision in Celsius is greater than that required in the Fahrenheit units. We suggest that temperatures in Celsius be rounded to the nearest 0.5° which is approximately the same implied precision as 1°F. In this case as well as in other places in the specification, conversion from metric to english should be made in accordance with recognized practice.

III.A.1. It is not certain what the effect of wide versus narrow rim width is on rolling resistance. Consequently, it is recommended that test rims be those specified by the Tire & Rim Association, Inc. as "design rim width," ± one-half inch.

For tire sizes not standardized by the Tire & Rim Association, Inc., reference should be made to the standardizing organizations listed in Federal Motor Vehicle Safety Standard 109.

III.A.2. The inflation pressures should be rounded to the nearest whole number, whether in metric or english units, to be consistent with recognized practice. In the case of P-type tires therefore, 26.1 psi should be changed to 26 and 31.9 psi should be changed to 32.

We have noted that certain typographical errors contained in the preprint of SAE J1269 have been carried over

into your document, for example, 41.4 kPa should be 414 kPa, 68 kPa should be 6.9 kPa.

The test pressures specified in SAE J1269 (32 psi for alpha-numeric and 35 psi for P tires) is considered to be more representative of current and near future recommended inflation pressures for new vehicles. Also, tire manufacturers and others are recommending higher tire inflation pressures for improved fuel economy and treadwear. Consequently, we believe test pressures more consistent with the capped pressure of paragraph 5.2 of the SAE recommended practice and tire industry recommendations are preferable.

Since T-type tires and collapsible spare tires are intended for use one tire at a time over short distances until the vehicle owner can repair the standard tire on his car, their use on a continuing basis should not be encouraged by including them in your rolling resistance considerations. Although SAE J1269 encompasses all kinds of passenger car tires, inclusion of temporary spare tires will not impact on energy conservation.

III.B. Tires vary widely in their rate of growth during break-in. In SAE J1269, the need for break-in is left to the judgment of the tester depending on the nature of the tire being tested. Similarly, the draft procedure should be revised to permit the tester to determine the need for break-in. Data available at this time indicate that radial tires do not require any break-in to stabilize tire dimensions.

III.D.1. In most testing facilities it is impractical to check inflation pressures while the tire is loaded on the test machine. Since there is no significant difference between inflation pressures measured while the tire is loaded versus unloaded, checking inflation pressure when the tire is unloaded should be specified in accordance with typical test practice.

The inflation pressure accuracy is unnecessarily restrictive for the requirements of the draft test procedure. To be consistent with our comments under III.A.2., we believe the inflation pressure accuracy should be 1 psi (7 kPa). Therefore, the gauge accuracy should be 0.5 psi (3 kPa).

III.D.4. The EPA draft calls for measurement of parasitic loss by what is commonly called "skim reading." Many laboratories measure parasitic loss by "machine reading." The different test equipment currently in use in the industry requires that the alternate parasitic loss methods contained in paragraph 6.6.1 and 6.6.2 of SAE J1269 be permitted. Choosing only one method unnecessarily forces the selection of specific test equipment.

IV.A. There are apparent typographical errors in this paragraph: E.3 should be D.4; E.2 should be D.3; "of" in the second line should be "from."

Sincerely,

Thomas E. Cole
Vice President
Tire Division

TEC/kk

1909 K STREET, N.W., SUITE 300
WASHINGTON, D.C. 20006

366 MADISON AVENUE
NEW YORK, NEW YORK 10017

MOTOR VEHICLE MANUFACTURERS ASSOCIATION
of the United States, Inc.
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BROOKS McCORMICK, *Chairman*
V. J. ADDUCI, *President and Chief Executive Officer*
THOMAS H. HANNA, *Senior Vice President*

April 28, 1980

Mr. Charles Gray, Jr., Director
Emission Control Technology Division
U. S. Environmental Protection Agency
2565 Plymouth Road
Ann Arbor, Michigan 48105

Dear Charles:

MVMA appreciates the extensions of time you granted to allow preparation of our comments on the Draft of the EPA Recommended Practice for Determination of Tire Rolling Resistance Coefficients. These comments are attached.

The vehicle manufacturers will comment individually on the Draft of the EPA Recommended Practice for Grading and Labeling of Tires for Fuel Efficiency.

If you or your representative would like to discuss these comments with the appropriate industry personnel, we will be pleased to arrange for such a meeting.

Sincerely,

Harry B. Weaver

Harry B. Weaver
Assistant Director, Engineering

AES/kd
Attachment

Motor Vehicle Manufacturers Association
COMMENTS ON DRAFT EPA RECOMMENDED PRACTICE FOR DETERMINATION OF TIRE ROLLING RESISTANCE COEFFICIENTS

II.A.2. Test Machine Control Accuracy

- SI Unit should be 1.6 km/h

II. Test Equipment
IV. Data Analysis

- In addition to force techniques, others such as torque and energy should be allowed as discussed in SAE Recommended Practice J-1269 "Rolling Resistance Measurement Procedure for Passenger Car Tires."

III.A.2. Inflation Pressure

- Eliminate "T" Type Tires since these are temporary usage tires.
- Alpha Numeric Size Tires should be tested at 32 psi and equal loads, in order to avoid the rank ordering within the various tire load ratings.
- "P" Type Tires should be tested at 35 psi and equal loads, in order to avoid rank ordering within the various tire load ratings.
- Typographical errors: 41.4 kPa should be 414kPa, and 68 kPa should be 6.8 kPa.

III.B. Tire Break-in

- Change title to "Tire Break-in for Non-Radial Tires" and reflect this in the first sentence.

III.D.1. Installation on the Test Machine

- Set tire pressure prior to loading of the tire to protect the operator

III.D.3.d. Rolling Resistance Measurements

- The angular velocity measurement on the tire requires instrumentation additional to the SAE practice, and is not necessary for the determination of parasitic losses.

III.D.4. Measurement of Parasitic Losses

- The parasitic machine loss skimming method contained in the draft may cause variations and therefore is not adequate.

IV.A. Subtraction of Parasitic Losses

- III.E3 should be III.D4, and III.E2 should be III.D3.

COMMITTEE F-9
ON
TIRES

ASTM, 1916 Race St., Philadelphia, PA 19103 (215) 299-5400

Chairman: H. G. SCHWARTZ, E. I. du Pont de Nemours and Co., Inc., 4330 Allen Rd., Stow, Ohio 44224 (216-929-2961)
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Staff Manager: R. M. SHERWOOD (215-299-5510)

April 21, 1980

Mr. Charles L. Gray, Jr., Director
Emission Control Technology Division
United States Environmental Protection Agency
Ann Arbor, Michigan 48105

Dear Mr. Gray:

Mr. Gerald R. Potts, Chairman, Subcommittee F9.20, ASTM Committee F-9, on Tires transmitted your recent letter with attached drafts of the EPA Recommended Practices (a) for Grading and Labeling of Tires for Fuel Efficiency, and (b) For Determination of Tire Rolling Resistance Coefficient to F-9.20 Committee members and asked them to respond directly to you.

In response to Mr. Potts' request, I am forwarding to you my comments to the proposed EPA Recommended Practices.

(a) EPA Recommended Practice for Determination of Tire Rolling Resistance Coefficients.

1. The values of inflation pressure specified in the proposed procedure do not reflect a current trend showing an increase in tire pressure by the industry and driving public and, therefore, may become obsolete in the near future. It is recommended to increase these values.

2. Loading the tire prior to checking inflation pressure is undesirable because it may reduce test efficiency. An inverse sequence, commonly used by most test laboratories, is recommended.

3. Requirements for determination of tire energy dissipation force from measured values of spindle reaction force introduce unreasonable restriction in the test procedure. It is recommended to specify the torque and energy methods as alternatives to spindle reaction force measurements.

4. Measurement of parasitic losses on the tire contacting the drum surface may adversely affect precision of measurements. To improve precision it is recommended to perform the measurement on a tire completely disengaged from the drum surface.

5. Rolling resistance coefficient vary with ambient temperature. $1^{\circ}F$ increase of temperature produces approximately 0.4% decrease of rolling resistance coefficient. To illustrate the significance of the effect of temperature variations within the $\pm 5^{\circ}F$ limits specified in the proposed procedure, it is assumed that the value of coefficient at $75^{\circ}F$ is equal to .012; then the values of rolling coefficient at temperatures of $70^{\circ}F$ and $80^{\circ}F$ become:

$$C_{70} = .012\ (1 + 0.004\ (75-70)\ ) = .0122 \text{ (Grade B)}$$

$$C_{80} = .012\ (1 + 0.004\ (75-80)\ ) = .0117 \text{ (Grade A)}$$

Since such temperature variation significantly effect the value of rolling resistance coefficient which even results in change of tire grading, it is recommended that rolling resistance coefficient should be corrected for change of ambient temperature and normalized to a nominal temperature.

6. There are few typographical errors in the proposed draft. Surface speed specified in Section II A2 is 1 Km/h instead of 1.6 Km/h. Inflation pressures specified in Section III A2 are 41.4 kPa instead of 414 kPa and 68 kPa instead of 6.8 kPa.

(b) EPA Recommended Practice for Grading and Labeling of Tires for Fuel Efficiency.

1. Limitations of applicability of rolling resistance coefficient of a free rolling tire as a criterion for grading of tires for fuel efficiency of driven automobiles should be clearly stated in the introduction to the Proposed Recommended Practice. The reasons for this statement are explained in the following discussion.

Tires have a significant effect on the fuel consumption of a vehicle because of the energy dissipation in the tire. Energy dissipation in the tire results from deformation of the tire produced by forces transmitted through the tire. Load carried by the tire produce vertical deformation. Energy dissipation due to this deformation constitute rolling resistance.

Driving forces propelling the vehicle produce circumferential deformation. Circumferential deformation produced by driving forces not only cause a direct energy dissipation due to this deformation, but also tend to modify pressure distribution along the length of tire contact which results in shifting the point of application of the resultant vertical force forward. This shift tends to further increase tire rolling resistance. Therefore, energy dissipation in the driven tire is considerably greater than that in the free rolling tire.

Furthermore, tires generate lateral forces which are necessary for directional control of a vehicle and for maintaining direction stability. These forces result from lateral deformation of the rotating tire operating at a slip angle. Additional dissipation of energy in a tire occurs during this process. Since vehicle continuously tends to change its direction of motion even in so-called "straight ahead" driving, energy dissipation due to lateral deformation continuously takes place. Vehicle fuel consumption is influenced by the total energy dissipation resulting from vertical, circumferential, and lateral deformation of the tire.

The magnitude of these deformations and consequently the magnitude of energy dissipation are effected by vehicle operating conditions, environmental conditions, and tire construction. Tire vertical, circumferential, and lateral stiffnesses may be considered as major tire design factors affecting tire deformations and energy dissipation. Tire grading for fuel consumption based exclusively on rolling resistance (vertical deformation) can be justified only if one would assume that tires showing low or high energy dissipation in a free-rolling mode also display correspondingly low or high dissipation in other tire modes and particularly in driving modes. Since there is no evidence supporting such an assumption, grading of tires for fuel consumption based on rolling resistance should be limited only to tires used on towed vehicles and cannot be used for tires used on driven automobiles.

2. To evaluate the proposed EPA grading system, five different tires tested in three different laboratories (identified as Facilities F, G, and H in the SAE Paper 780636) were graded in accordance with this system. Test data used for grading was obtained from tests conducted on a 67" diameter drum in accordance with the EPA Recommended Practice of 50 mph speed, 24 psi inflation pressure, and 80% rated load. The rolling resistance force was determined from the measured value of drum torque in Laboratories F and G, and from the spindle force in Laboratory H. Measurements in different laboratories were conducted at different ambient temperatures but the reported values of rolling resistance force were corrected to a common temperature of $70^{o}F$. The values of rolling resistance coefficient were calculated from measured values of rolling resistance force and corrected to $70^{o}F$ temperature as follows:

$$RRC_{75} = RRC_{70} \ (1 + 0.004 \ )70-75) \ )$$

The upper limit (X_{u}) of rolling resistance coefficient was determined in accordance to the EPA Recommended Practice. Because of lack of actual data, I assume that the value of standard deviation for each of the test tires is equal to 0.00044 and the sample size is equal to 24. By using these assumptions I determine the value of K-factor from Table 3 in the proposed EPA Recommended Practice, K = 1.712. These values were used for calculation of the upper limit of rolling resistance coefficient for all five tires. Calculated values are summarized in Table 1, which also contains a complete data necessary for these calculations. The values of the upper limit of rolling resistance coefficient were used for grading of tires for fuel efficiency. The grading was performed in accordance with the proposed EPA Recommended Practice. The results of grading are summarized in Table 1.

Table 1 shows that tires tested in three different laboratories received the same grading. Radial tires received grading B and C: however, all bias and bias-belted tires received the same gradeD. Unfortunately, the values of rolling resistance coefficient of bias and bias-belted tires were beyond the lower limit of the grading scale. Therefore, in spite of considerable difference between the rolling resistance values of these tires, they received the same grading. To enable one to grade the bias and bias-belted tire, it is recommended to expand the proposed grading scale as it is shown in Table 2. By applying the expanded scale for grading of tires, whose data is summarized in Table 1, one may find that bias-belted tires received higher

grades than the bias tire. Furthermore, it was also possible to differentiate between the fuel efficiency of two different bias-belted tires, A78-13 and L78-15, which received grade E and D, respectively. Tire grades established by using expanded scale are also incorporated into Table 1. The expanded scale also has an additional grade AA at the upper end of the scale. The addition of this grade will give tire manufacturers an incentive to further improve tire fuel efficiency.

3. If sufficient evidence exists that the rolling resistance coefficient of a free rolling tire can be used as a reliable criterion for grading of free rolling-as well as driven tires for fuel efficiency, grading of tires then may be used as a guide for selection of tires for fuel efficiency. However, it is still doubtful that the proposed grading and labeling of tires will satisfy the needs of a consumer. In order to decide which tire to buy, the consumer probably would like to know how much gasoline he is going to save by purchasing higher grade tires. The difference in average fuel consumption for different grade tires determined perhaps at conditions used for specifying vehicle fuel consumption (EPA fuel mileage) should be stated in order to provide customers with a meaningful guide. Furthermore, it is also important to evaluate possible benefits of grading of tires against expenditures (testing, labeling, etc.). It would be highly objectionable if grading tires for fuel efficiency became another contributor to the problem of national inflation.

4. There is a typographical error in Table 1, which shows that for Grade D tire, the rolling resistance coefficient should be RRC >0.016 instead of RRC > 0.015.

I hope that my comments may be useful to you.

Sincerely,

W. Bergman

W. Bergman

TABLE 1 - GRADING OF TIRES FOR FUEL EFFICIENCY IN ACCORDANCE WITH THE PROPOSED EPA RECOMMENDED PRACTICE

	Test Facility	Tire Size and Type A78-13 Bias	A78-13 Bi-Belt	BR78-13 Radial	L78-15 Bi-Belt	LR78-15 Radial
Rolling Resistance Force (lb)	F	14.0	14.1	12.0	23.3	18.1
	G	14.0	12.9	10.9	23.4	17.2
	H	14.5	12.9	10.9	24.8	17.8
Vertical Load - Lb.	F-G-H	720	720	780	1340	1340
Rolling Resistance Coefficient at 70°F	F	.0194	.0196	.0154	.0174	.0135
	G	.0194	.0179	.0139	.0174	.0128
	H	.0201	.0179	.0139	.0185	.0133
Rolling Resistance Coefficient at 75°F	F	.0190	.0192	.0151	.0170	.0132
	G	.0190	.0175	.0136	.0170	.0125
	H	.0197	.0175	.0136	.0181	.0130
Upper Limit of RRC at 75°F	F	.0197	.0199	.0158	.0177	.0139
	G	.0197	.0182	.0143	.0177	.0132
	H	.0204	.0182	.0143	.0188	.0137
Fuel Efficiency Grade Determined by Using Grading Scale	F	D	D	C	D	B
	G	D	D	C	D	B
	H	D	D	C	D	B
Fuel Efficiency Grade Determined by Using Modified Grading	F	E	E	C	D	B
	G	E	E	C	D	B
	H	F	E	C	E	B

TABLE 2 - EXPANDED SCALE FOR GRADING OF TIRES FOR FUEL EFFICIENCY

Tire Rolling Resistance Coefficient	Tire Fuel Efficiency Grade
RRC $<$ .010	AA
.010 $\leq$ RRC $<$ .012	A
.012 $\leq$ RRC $<$ .014	B
.014 $\leq$ RRC $<$ .016	C
.016 $\leq$ RRC $<$ .018	D
.018 $\leq$ RRC $<$ .020	E
.020 $<$ RRC	F

FE-2053
Environmental Activities Staff
General Motors Corporation
General Motors Technical Center
Warren, Michigan 48090

May 15, 1980

Mr. Charles L. Gray Jr., Director
Emission Control Technology Division
Environmental Protection Agency
2565 Plymouth Road
Ann Arbor, Michigan 48105

Dear Mr. Gray:

This letter with attachment is in response to your proposed recommended practices for measuring tire rolling resistance coefficients and for the grading and labeling of tires for fuel efficiency. However, General Motors objects to EPA's assumption that it has the authority to grade and label tires for fuel efficiency. Nowhere in the Energy Policy and Conservation Act has Congress delegated to EPA, authority to grade and label tires. GM wishes to point out that Congress is now considering legislation which would authorize the Secretary of Energy to categorize tires according to their contribution to automotive fuel economy. Under the proposed legislation, it is the Secretary of Energy who, in consultation with the Administrator of EPA and the Society of Automotive Engineers, is to "...develop test procedures for determining the relative fuel economy attributable to the use of a specific tire compared to the use of another tire in the same category." See § 602(c) of S. 2015. What EPA purports to do by way of issuing a so-called "recommended practice" Congress is considering doing by way of legislation. General Motors submits that EPA cannot exercise power it does not have. Moreover, the national highway traffic safety administration has already promulgated requirements for new pneumatic tires. See 49 CFR § 571.109.

General Motors will continue to utilize the more detailed aspects of the SAE procedure which provide testing over a range of loads and pressures and, therefore, provide us with the capability of evaluating the rolling resistance at any number of specific conditions that would relate to actual vehicles. The only difference in this regard is related to the use of a regulated estimated "hot" pressure rather than the capped air concept. General Motors plans to further evaluate both methods.

Currently, there are rolling resistance requirements for GM original equipment tires on all new vehicle development programs and state-of-the-art low rolling resistance technology tires are now being used on over 50% of all GM passenger cars. They will be available on over 95% of all GM passenger cars by 1982. We believe it is important, however, that the fuel economy concerns of any governmental agency not be over emphasized to the extent of possible diminution of other tire performance characteristics such as handling, traction and wear, which are not necessarily indpendent of rolling resistance.

GM's comments on the technical merit of the EPA draft procedures are attached.

Sincerely,

T. H. Fisher, Director
Automotive Emission Control
Environmental Activities Staff

8RGF/430/E

GM COMMENTS ON EPA RECOMMENDED PRACTICES FOR MEASURING TIRE ROLLING RESISTANCE COEFFICIENTS AND GRADING/LABELING TIRES FOR FUEL EFFICIENCY

Procedural Comments on Measuring Tire Rolling Resistance Coefficients

- Inflation Pressure

  The multiple test pressures used for tires having different load ranges will likely cause the higher load range tires to obtain an artifically better grade. This approach could lead some consumers to purchase the higher load range tires for their application without utilizing the higher inflation pressure. For example, if a particular tire design is manufactured in LR-B, LR-C, and LR-D sizes, the higher fuel economy grade would be assigned to the LR-D tire even though we would expect it to exhibit poorer rolling resistance at a constant inflation pressure. Therefore, we would recommend that all passenger car tires of mulitiple load ranges be evaluated at a common inflation pressure.

  Since the "T" type high pressure spares are intended only for temporary usage, they should be deleted from this procedure.

- Tire Break-in

  GM agrees that the one-hour break-in is most important for the non-radial tires where tire growth could occur. The break-in growth effect on belted radial tires, however, will be far less and therefore the break-in is unnecessary. Omitting the break-in would have the tendancy to directionally lower the fuel economy grade (higher rolling resistance), but this is considered to be an insignificant change. By omitting this step for radial tires, the total elapsed time to conduct a test would be reduced by approximately 75%.

- Inflation Pressure Accuracy

  The stated accuracy of the pressure gauge (0.05 psi) is much greater than what is known to be commercially available for manually applied gages. Pressure losses greater than this could occur during the process of taking the pressure reading, which must be a manual operation. The estimated effect of a 0.5 psi (ten times the recommended accuracy) error in initial inflation pressure would be to affect rolling resistance by only 0.10 to 0.15 lbs., depending on the tire construction type. A gauge with 0.25 psi accuracy should be sufficient for this generalized characterization of tire rolling resistance performance.

o Parasitic Loss Measurements

The angular velocity measurements on the tire present an additional piece of instrumentation not needed in the normal SAE practice. Since tire angular velocity is load sensitive, and the principal intention of this measurement is to establish accurate parasitic loss measurements, then an alternate approach is recommended. This recommended approach would be to measure the rolling resistance and load at both the desired load condition (80% TRA) as well as at a light load condition (approximately 20-30 lbs.). The change in rolling resistance can be observed as well as the change in load, which permits the calculation of the rolling resistance coefficient as follows:

$$RR_c = \frac{\Delta\ RR}{\Delta\ Load}$$

This approach eliminates the need for angular velocity measurements, and also cancels the effects of any long-term instrumentation drift that may occur.

TIRE GRADING AND LABELING COMMENTS

o Tire Handling and Traction

The EPA should be advised that tire handling and traction are not necessarily independent of rolling resistance. While there currently appears to be a significant technology gap in rolling resistance between the OEM tires and some aftermarket tires, the EPA should not over emphasize tire rolling resistance without consideration of its impact upon other important tire performance characteristics. The OEM tires produced under the TPC system attempt to maintain a balance between these characteristics.

o Grade Labeling

The EPA proposed tire label appears to be a promotional advertisement for the EPA and is far larger than other information on the tire, while maintaintaining other desireable tire properties, and larger than we believe necessary. A simplified version such as "fuel economy grade B" in dimensions consistant with the tire quality grading label should be adequate.

o Effect of Size and Load on Fuel Efficiency Grade

We believe the principal intent of the tire fuel economy grading system is to encourage the development of lower rolling resistance tires and to accurately inform the aftermarket buyer of the relative fuel efficiency levels of different tire lines. The test data in Figure 1 (attached) indicates that there is a size relationship to rolling resistance coefficients such that smaller tire sizes have a higher rolling resistance coefficient than larger sizes, even though

they represent the same level of tire technology. Our analysis of this range of tires indicates that a full size line of equal technology tires would have as many as three different fuel economy ratings (i.e., A, B, and C). We feel this would lead to considerable confusion in the customer's mind, especially since some of the smaller size tires may not be capable of reaching a grade "A" level with todays best known technology. We would propose that an alternate criteria be considered. This criteria would encompass the inherent slope of the curve shown in Figure 1. The proposal would be to calculate an index that would be dependent on both the rated load and the upper limit on RR_c as described in the EPA proposed method.

Since the average trend (Figure 1) can be described by a best fit linear relationship in the form

$$RR_c = 1_o - K_L L$$

where: 1_o = intercept (index)

K_L = Slope of curve = $736X10^{-9}$

L = 80% TRA Load at design pressure - (Newton)

RR_c = Rolling Resistance Coefficient - (N/N)

then:

$$1_o = RR_c + (736X10^{-9})L$$

We would expect this trend to be valid over the range of tires shown in Figure 1. If one assumes that the 90% confidence/90% population limits have the same trend, then this equation would be:

$$1_o = RR_{c(ul)} + K_L L$$

where: $RR_{c(ul)}$ = Upper limit for 90% confidence on 90% of the population

K_L, L = Previously defined

Now, a fuel economy grading system can be developed around this index (1_o) concept. A suggestion would be:

$1_o \leq 0.015$.....Grade A

$0.015 < 1_o \leq 0.017$.....Grade B

$0.017 < 1_o \leq 0.019$.....Grade C

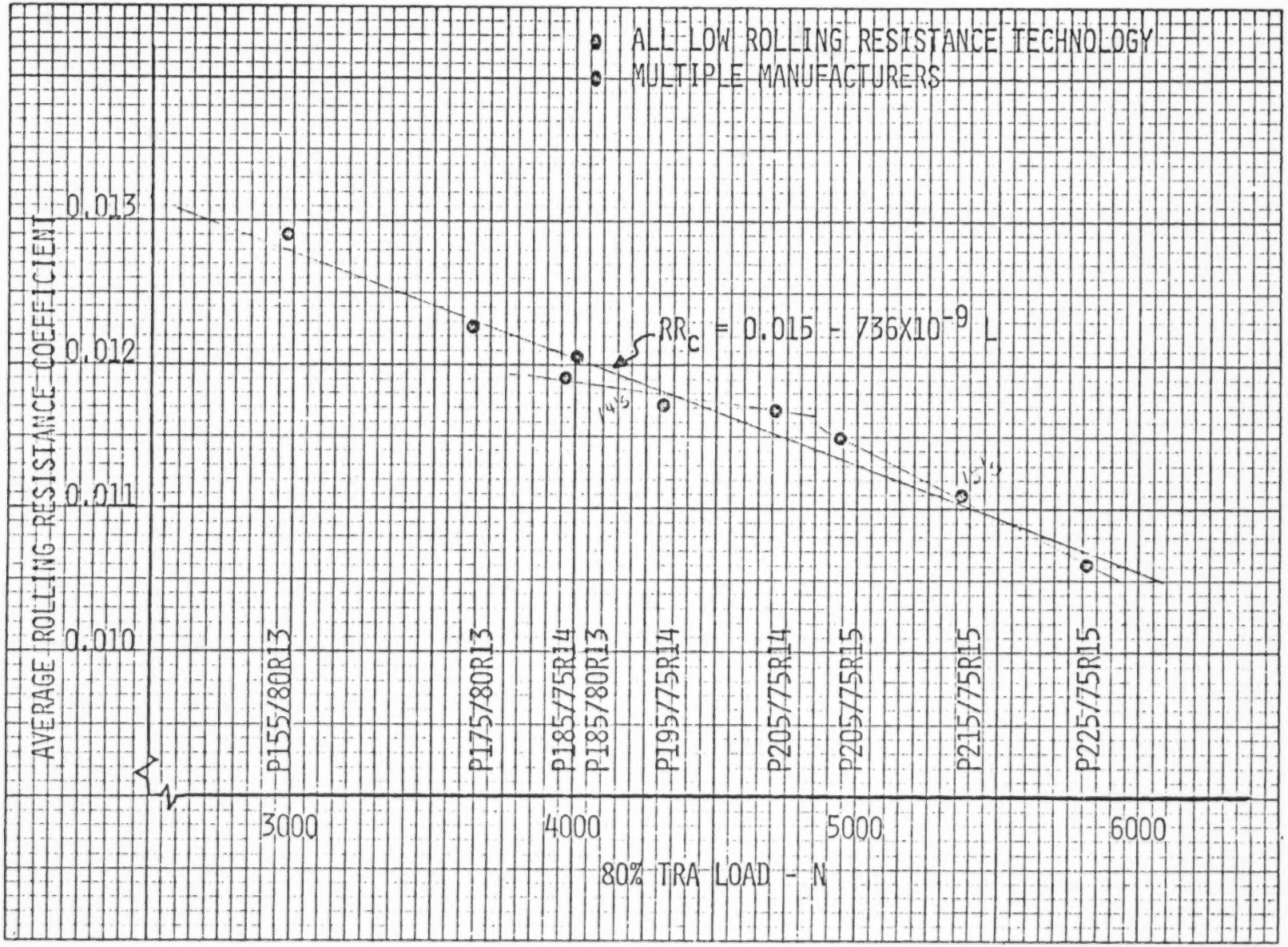
$1_o > 0.019$.....Grade D

We would expect this fuel economy grading method to be valid over the 13, 14, and 15 inch passenger car tire sizes which represent the majority of tires used today.

8RGF/430/E1

FIGURE 1

ROLLING RESISTANCE COEFFICIENT VS 80% TRA LOAD



RCM 4/24/80

Helen O. Petrauskas
Assistant Director
Automotive Emissions and
Fuel Economy Office
Environmental and Safety
Engineering Staff

Ford Motor Company
The American Road
Dearborn, Michigan 48121

June 18, 1980

Mr. Charles L. Gray, Jr.
Director
Emission Control Technology Division
U.S. Environmental Protection Agency
2565 Plymouth Road
Ann Arbor, MI 48105

Dear Mr. Gray:

Enclosed are comments prepared by Ford Motor Company with respect to a document entitled "EPA Recommended Practice for Grading and Labeling of Tires for Fuel Efficiency". We believe grading and labeling of tires with respect to fuel efficiency would be worthwhile only if such information could be imparted to consumers in an accurate, meaningful, and effective manner. Our principal concerns in this regard are (i) the accuracy and technical validity of equating tire fuel efficiency and rolling resistance, (ii) the difficulty of stating tire efficiency in some objective manner which would be understandable to the consumer, and (iii) the effectiveness with which tire fuel efficiency ratings can be communicated in light of the existing requirements to make known ratings related to other tire characteristics.

These concerns have led us to conclude that, at present, fuel efficiency grading and labeling of tires should not be implemented.

Sincerely,

H. O. Petrauskas

Attachment

COMMENTS OF FORD MOTOR COMPANY
WITH RESPECT TO
EPA RECOMMENDED PRACTICE FOR GRADING AND
LABELING OF TIRES FOR FUEL EFFICIENCY

I. Purposes of Grading and Labeling Requirement

If labeling of tires is intended to assure that low rolling resistance tires are used as original equipment parts, labeling is not necessary. There exists a high motivation for vehicle manufacturers to provide optimum tire designs to maximize fuel economy--to meet consumer demand and federally mandated fuel economy standards.

If labeling is intended to aid the consumer in making an informed choice in the purchase of replacement tires, several questions regarding the relative merit of this additional information must be considered.

II. Effectiveness

Tire manufacturers are already required by the Uniform Tire Quality Grading Standard (49 CFR 575.104) to provide ratings of treadware, traction and temperature resistance in symbols. In our opinion, without explanation these ratings offer limited guidance to the consumer. If, as indicated above, EPA also intends this labeling of the tire fuel economy to be an aid to consumers, the adoption of the proposed EPA "Fuel Economy Grade" label on the sidewall of tires would appear to compound the existing complexity in the purchase of aftermarket tires by adding another indicator (of unknown value) of tire performance characteristics.

If the agency believes that fuel economy labeling would be beneficial to the consumer, it should ensure that such labeling is (a) understandable, meaningful and useful and makes clear to the user the differences in projected fuel economy at each grade rating; and (b) that any tradeoffs introduced into the existing Uniform Tire Quality Grading indicators by this fourth variable are adequately investigated and understood. Each of the present UTQG grades are footnoted by explanations of the particular grade marking. It is believed that the fuel economy rating on the tire would also require extensive explanation, which would dilute its value to the consumer.

Further, it is believed that before any relevance to fuel economy can be claimed as a consumer aid, research into the usefulness of the proposed information should be completed to attempt to determine:

- Does the buyer understand the information offered? Can he relate each grade level to some generally understood measure (miles per gallon)? Would they use it in making a purchasing decision?

direction stability. These forces result from lateral deformation of the rotating tire operating at a slip angle. Additional dissipation of energy in a tire occurs during this process. Since a vehicle continuously tends to change its direction of motion, even in so-called "straight ahead" driving, energy dissipation due to lateral deformation continuously takes place. Vehicle fuel consumption is influenced by the total energy dissipation resulting from vertical, circumferential, and lateral deformation of the tire.

The magnitude of these deformations and consequently the magnitude of energy dissipation are affected by vehicle operating conditions, environmental conditions, and tire construction. Tire vertical, circumferential, and lateral stiffnesses may be considered a major tire design factor affecting tire deformations and energy dissipation. Tire grading for fuel consumption based exclusively on rolling resistance (vertical deformation) can be justified only if one would assume that tires showing low or high energy dissipation in a free-rolling mode also display correspondingly low or high dissipation in other tire modes and particularly in driving modes. Since there is no evidence supporting such an assumption, grading of tires for fuel consumption based on rolling resistance may not be applicable to tires used on driven automobiles.

IV. Authority to Require Grading and Labeling of Tires

Ford believes that EPA lacks the authority to promulgate any regulations concerning tire labeling. EPA has the authority, pursuant to the Energy Policy and Conservation Act, P.L. 94-163, to measure vehicle fuel economy, to calculate corporate average fuel economy, and to require fuel economy labeling of vehicles; but authority is not granted to rate or label the component parts of the vehicle with regard to fuel economy effects. This conclusion is supported by the fact that Amendment 1663 to S. 2015, proposes to require testing and labeling of tires for fuel economy effects. Congress then seems to have concluded as well that EPA presently lacks the authority to perform these functions.

V. Miscellaneous

If labeling of tires were adopted, we recommend that:

- It should not be applicable to "T" type tires (temporary tires).

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- For the sake of completeness the RRC scale be expanded--

lower than RRC = 0.012
...say RRC = 0.010

greater than RRC = 0.015
...say RRC = 0.020